FY 01 SITE Program Cost Savings and Vendor Benefits

Promotion of Innovative Technologies

SITE is recognized by EPA as one of its principal programs to advance innovative site monitoring, characterization, and cleanup technologies with the potential to treat hazardous wastes more efficiently, less expensively, and more safely than existing methods. SITE's mission is to promote the development and application of innovative technologies that reduce or eliminate risks to human health and the environment due to contamination. The goal of the program is to interact with the technology user community, understand its needs, integrate those needs with EPA's research mission, and expeditiously address those needs. Identifying and responding to the technology needs of the remediation community is the driving force behind today's SITE Program.

Responding to technology needs is the driving force behind the SITE Program.

The need for credible and reliable data for innovative technologies is significant. Often, Records of Decision (RODs—official records documenting selection of Superfund site cleanup methods) indicate that innovative technologies were not chosen due to a lack of verified performance and implementability. The SITE Program serves to fill this need for credible evaluations so that more effective, cost-efficient methods can be used on remediation problems.

The types and numbers of innovative technologies selected for remediation at Superfund sites increased significantly after the passage of the Superfund Amendments and Reauthorization Act (SARA). Since then, the number has continued to rise, indicating increased credibility and confidence in a number of innovative treatment technologies. As a result, more innovative technologies than conventional technologies were selected in RODs signed during FY 93 through FY 00.

During the first 10 years of the SITE Program, an emphasis was placed on innovative technologies for permanent treatment that usually required the removal (ex situ) of soil or groundwater. Most field demonstrations during this period in the program's history involved ex situ physical/chemical and thermal technologies that could be field tested in a matter of days or weeks. The need for innovative, in situ technologies that are more cost-effective, result in less secondary waste, and are less intrusive will continue to increase. The SITE Program has recognized this need and has emphasized the development of in situ technologies.

Figure 1 presents the number of in situ technologies as a percentage of all treatment technologies for source control by fiscal year. Over time, use of in situ technologies has been increasing, as the trendline in Figure 1 shows. A five-year moving average of the percentage of in situ treatment technologies shows a generally steady increase from 28 percent (FY1985-1988) to 51 percent (FY1995-1999). Several factors may play a role in this upward trend in the use of in situ treatment technologies. Because in situ technologies require no excavation, risk from exposure to contaminated media is reduced,

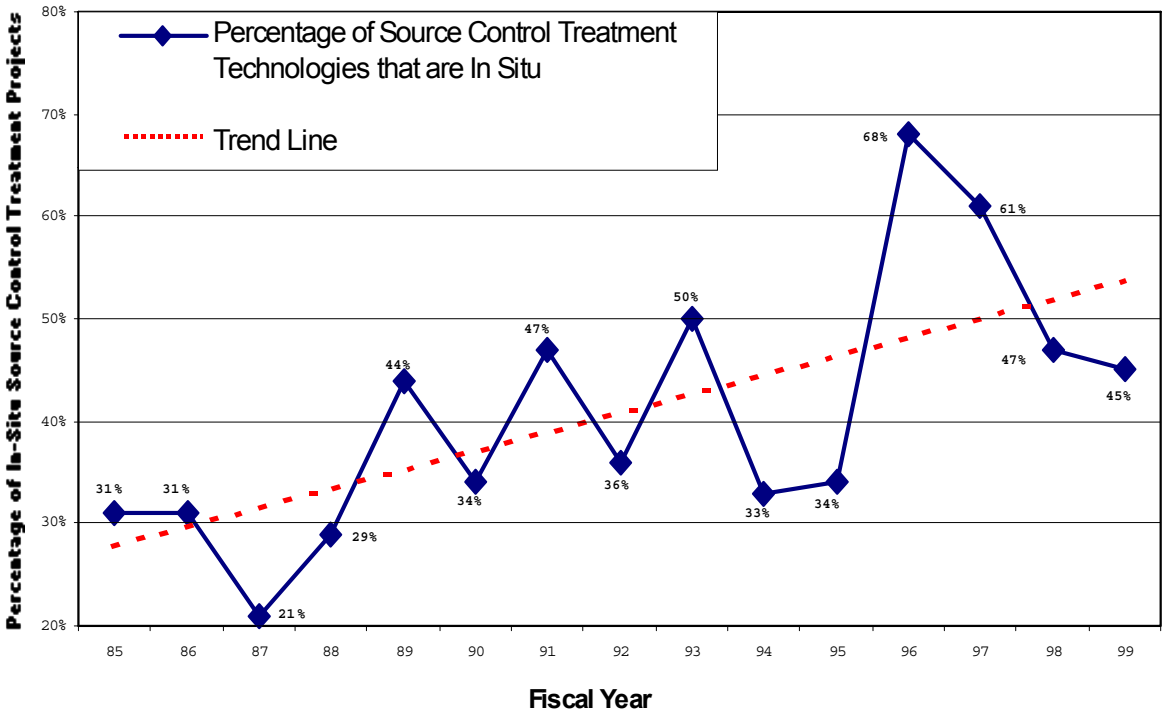


Figure 1. Superfund Remedial Actions: In Situ Technologies for Source Control (FY 1985- FY 1999)

Source: U.S. EPA Office of Solid Waste and Emergency Response, Innovative Treatment Technologies Annual Status Report, Tenth Edition (542-R-01-004)

compared with levels of risk associated with technologies that do require excavation. Further, for large sites where excavation and materials handling for ex situ technologies can be expensive, in situ technologies are often more cost-effective.

Historical Program Cost Savings and Vendor Contracting

Since its establishment in 1986, the SITE Program has assisted in the development and use of innovative technologies, resulting in substantial cost savings for cleaning up contaminated sites. The cost savings realized by federal facilities has been estimated by analysis of RODs from 1993 - 1999; this analysis is described below. RODs data is made available for the fiscal year that is two years prior to this report. Thus FY 1999 RODs information is presented here. New Cost Information from 2000 RODs will be included in the Report to Congress FY 2002. The SITE Program has also assisted vendors in advancing innovative technologies from the development phase to full-scale application, and has promoted greater acceptance of these technologies. The following subsections provide examples of the financial success of the SITE Program in terms of federal cost savings and vendor successes.

SITE Program Accomplishments - Federal Cost Savings from RODs Analysis

Since 1993, the use of innovative technologies has outpaced that of established technologies, resulting in dramatic cost savings. During 1996, 1999, 2000, and 2001, the SITE Program collected information from signed RODs (dated 1993-1999) in all 10 EPA Regions that selected an innovative technology as the remedy. These technologies include soil vapor extraction, thermal desorption, bioremediation, phytoremediation, surfactant flooding, and many other technologies that have passed through the

Program. The data compiled by the SITE Program allowed environmental managers to compare innovative technologies to conventional technologies *(i.e. pump and treat technologies, incineration and excavation and land filling)*, especially with updated data on a total of 195 RODs that selected innovative technologies for part or all of the remediation. As the innovative technologies discussed in this report become more accepted and used as the baseline for remediation, they will be viewed as conventional technologies for comparison to newer technologies. The SITE program will periodically evaluate whether technologies that are no longer considered innovative should be added to the baseline of conventional technologies. The Program will conduct this review in FY 2002 and thereafter on a five year basis.

EPA guidance recommends that ROD estimates assess remedial alternatives with an accuracy of +50 percent to -30 percent. Of the 195 RODs that selected innovative technologies, 98 had sufficient information to make a cost comparison between the selected technology and a conventional technology. Cost savings realized by using innovative technologies for the 98 RODs was estimated at $2.6 billion in 2000 dollars, with an average percent savings per site of 72 percent. Only 13 of the 98 RODs reported that the innovative technology was more expensive than or equal to the established technology.

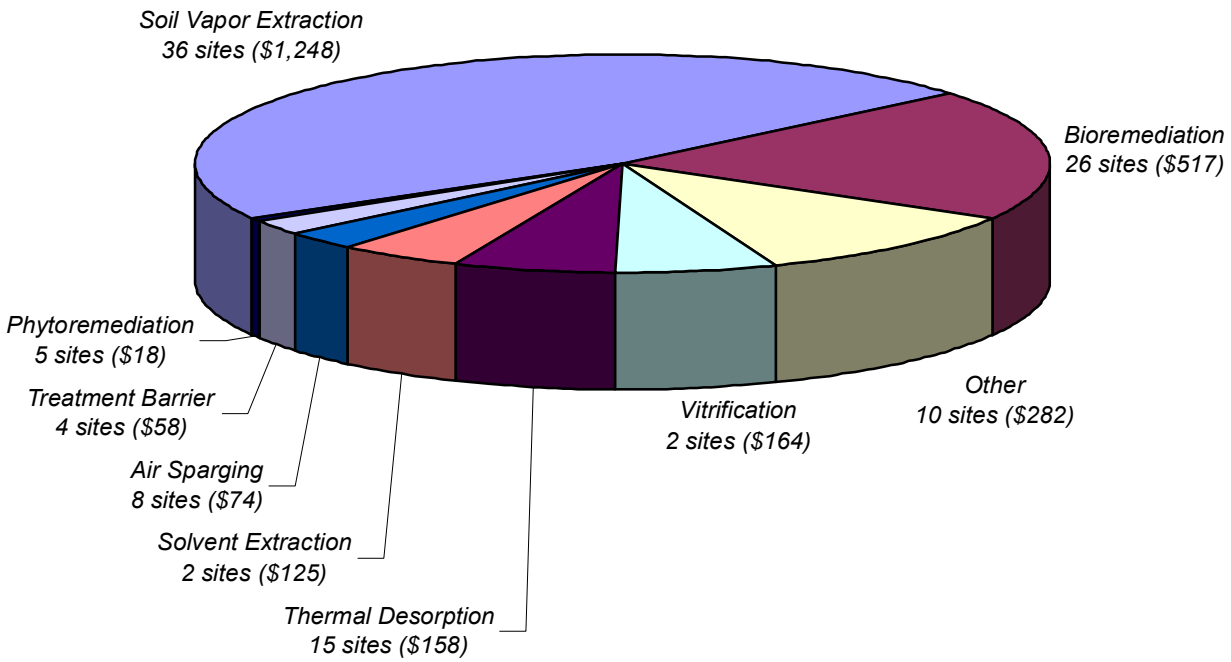
To estimate SITE Program net benefits, the FY 93-99 RODs and the SITE Program budget were inflated to the end of 2000 using Consumer Price Index (CPI) inflation figures. The total inflated cost savings for RODs dated 1993-1999 was $2.6 billion, and the total inflated SITE Program budget from 1986-2000 was $ 181 million. This comparison represents an estimated inflated cost savings of over $ 2.4 billion for various site cleanups.

Figure 2 shows a breakdown of savings by technology type. Soil vapor extraction (SVE) showed the highest savings of over $1.25 billion, followed by $517 million for bioremediation. SVE was one of the initial technologies accepted into the SITE Program (in the late 1980s), and large savings would therefore be expected from this technology. Solvent extraction, thermal desorption, and vitrification each accounted for over $100 million in savings. Phytoremediation and permeable reactive barriers are newer technologies that are beginning to be chosen in RODs, with five and four sites having specified their use, respectively, with an associated cost savings of $76 million as compared to conventional technologies. The number of sites and associated costs savings for phytoremediation and treatment barrier sites are expected to increase rapidly in coming years.

Historical Vendor Benefits

Technology vendors are a central part of the SITE Program, providing remediation services for sites requiring clean-up solutions. Vendors experience various benefits by participating in the SITE Program, namely increased exposure, market share, technical acceptance, and recognition. Increased acceptance of innovative technologies is demonstrated by the level of commercial activity experienced by SITE Program vendors. For example, 1999 information indicated that since completing SITE demonstration projects, vendors received 1,921 remediation contracts, and 1,308 treatability studies (Figure 3). 2001 vendor information was not available at the time of submission of this report. This information will be included in the Report to Congress FY 2002.

As part of a SITE Program evaluation in 1999, 43 Demonstration Program vendors provided information regarding company revenues after completion of their demonstration. Following participation in the SITE Program, 58 percent of the responding vendors were awarded commercial remediation jobs using technologies demonstrated in the SITE Program. Thirty-three



Savings estimates based on comparison of innovative and conventional technologies for FY 93-99 RODs. Savings shared equally among technologies when multiple technologies were used and technology-specific costs were not available.

Figure 2. Cost savings estimated from RODs analysis by technology type (millions of 2000 dollars).

percent of the vendors were awarded more than 10 contracts each. Over 35 percent reported one or more international contracts, identifying 37 countries where jobs were contracted. Figure 4 provides a historical perspective of growth in the number of contracts awarded to SITE vendors from 1990 to 1999.

The 1999 Demonstration Program vendor information has been broken down by technology type to ascertain which technologies demonstrated the greatest commercial success. Figure 5 shows the share by technology type of the 3,229 remediation and treatability contracts awarded to vendors. It is clear from this chart that soil vapor extraction and bioremediation technologies have had the most commercial success.

This trend from the vendor information is consistent with the RODs analysis results which were shown in Figure 1, providing two sources of data to confirm the outstanding commercial success of these technologies.

> "Our involvement with the SITE Program and especially our EPA Project Officer, Ed Bates, has been very successful. We appreciate everyone's efforts and the program's agenda."
>
> Scott Larsen, STC Remediation, Inc.
> (Chemical Fixation/Solidification Technologies)

In addition to the 43 Demonstration Program vendors, information was obtained

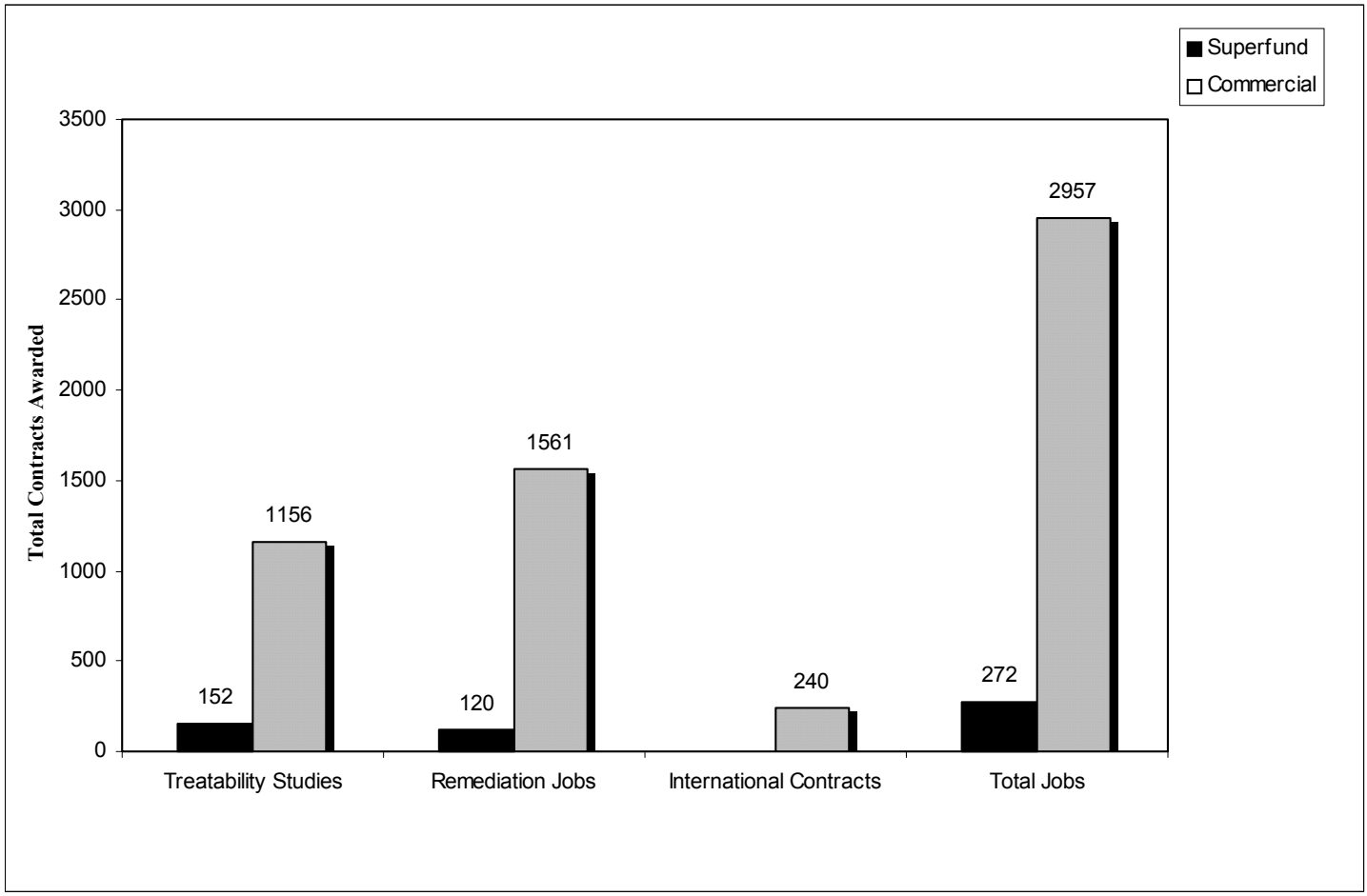


Figure 3. Categorization of contracts awarded to SITE vendors following program participation. (Source: 1999 vendor information)

in 1999 from 14 vendors that participated in the MMT Program. This information clearly demonstrated the benefits that vendors receive from the program, indicating that 71 percent of the vendors sold more than 25 units since their demonstration in the SITE Program. Over 64 percent of the vendors indicated that their technologies were used on international remediation projects. In total, the MMT vendors reported selling over 3,550 units on 900 jobs, including 48 international jobs.

Overall, vendor information shows that SITE technology developers in the Demonstration and MMT Programs are achieving commercial success for demonstrated technologies. The impact of the SITE Program continues to grow over time, as illustrated by the consistent growth in vendor contracts over the last decade (Figure 4).

Innovative Technology Highlights - - SITE Program Case Studies

This section presents case studies of innovative remediation technologies for vendors that have participated in the SITE Program. The case studies provide brief descriptions on the use and status of representative technologies and, where available, general information on the cost of applying each technology. It is typical of the SITE Program and represents the SITE Program's approach to promoting innovative technologies by identifying user needs. In response to user needs, the SITE Program assessed the performance of several innovative field measurement devices for total petroleum hydrocarbons in contaminated soil and sediment, iron reactive barrier technology for in situ groundwater remediation, and a washing technology for oil-contaminated soil.

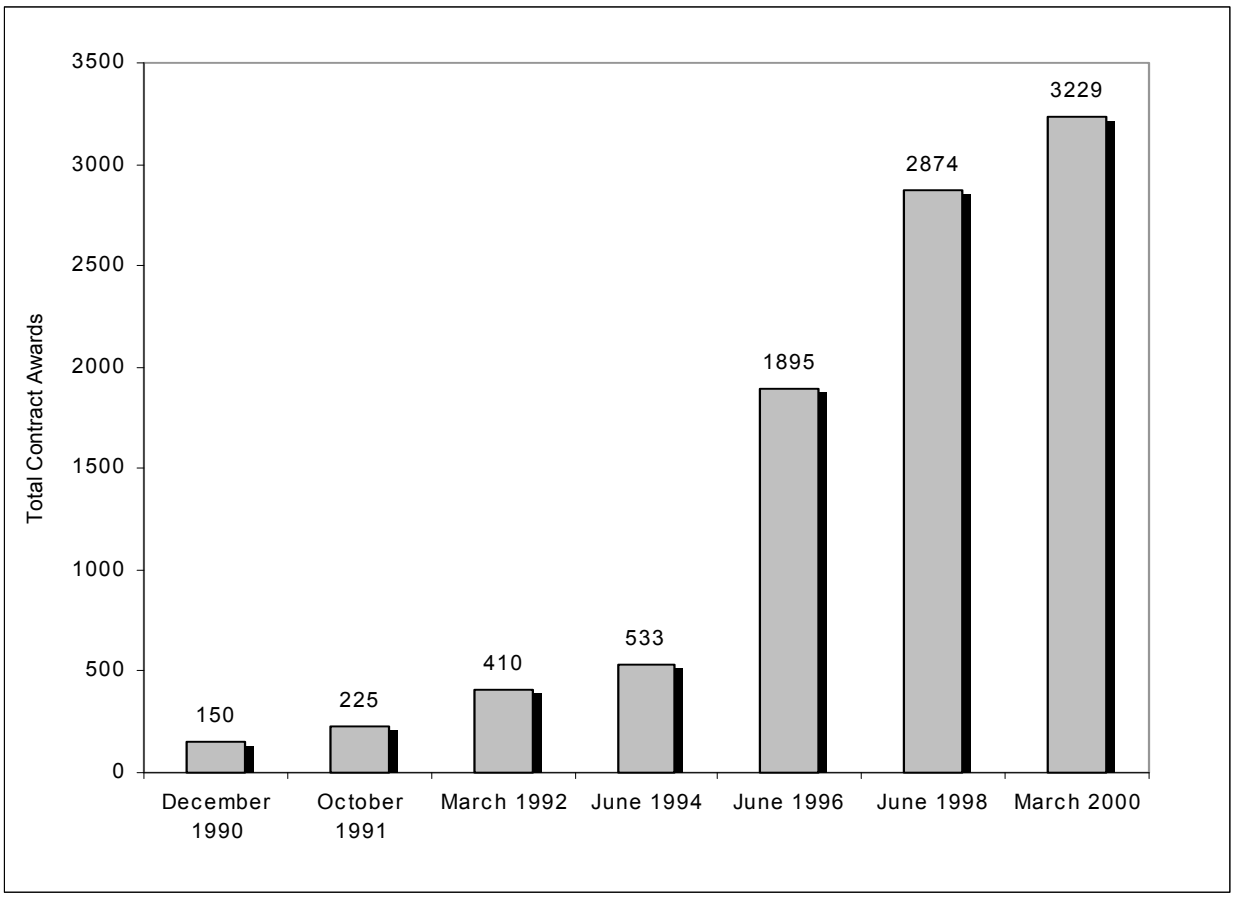


Figure 4. Total number of contracts awarded to SITE vendors after program participation (Source: 1990-2000 vendor information)

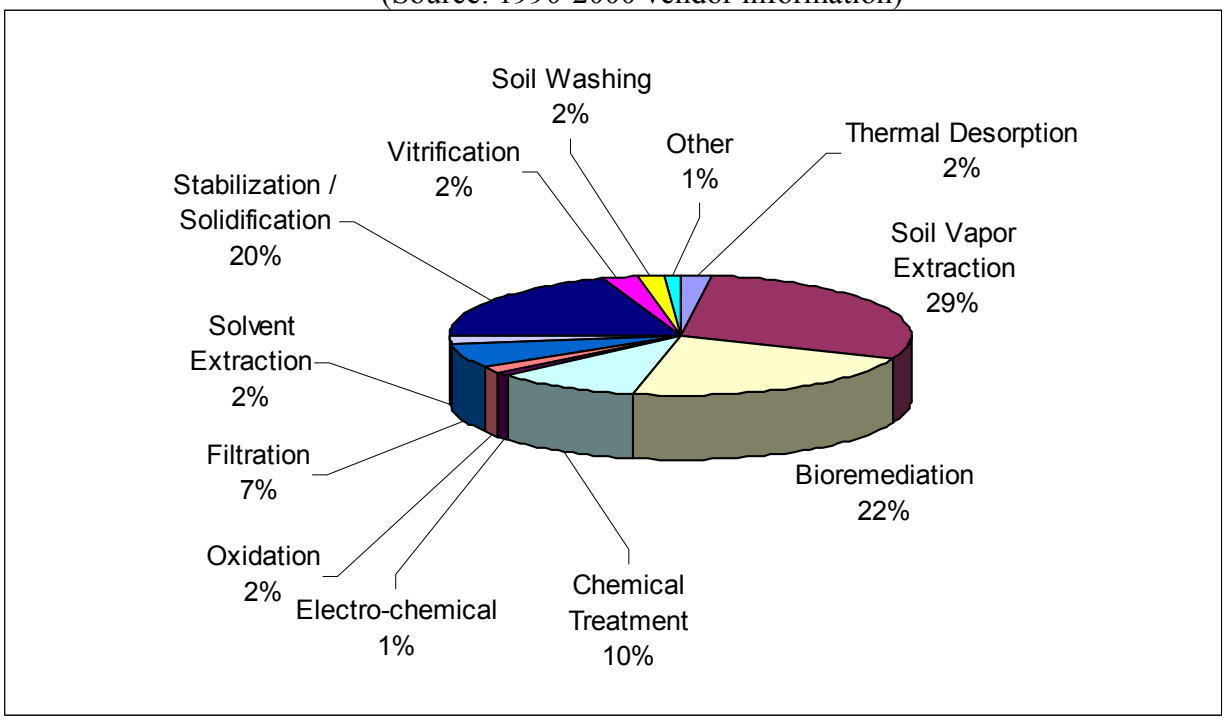


Figure 5. Share of 3,220 total contracts awarded to SITE Demonstration vendors by technology type (Source: 2000 vendor information)

SITE Program participants who responded indicated that they experienced up to an 800% increase in sales as a result of their involvement in the SITE Program.

Case Study 1: Iron Reactive Barrier (In-Situ Groundwater Remediation)

The U.S. EPA began working with the U.S. Department of Energy (DOE) in 1995 to characterize a contaminated groundwater plume at DOE's Rocky Flats site outside Denver, CO. DOE is working to achieve closure of the Rocky Flats site by 2006, and considers remediation of this plume a crucial element of site closure. Based on the results of site characterization and ongoing commitment to utilize innovative treatment technologies, DOE decided to remediate the contaminated groundwater through use of a passive barrier.

Groundwater contamination in this area originated from a former waste drum storage area used by DOE in the late 1950s. Consisting of shallow groundwater collected in a French drain and funneled to the reactors at a flow rate of 0.5 to 2.0 gallons per minute, the plume extends horizontally approximately 220 feet. Its primary contaminants are uranium and volatile organic compounds (VOCs), including carbon tetrachloride, tetrachloroethene, trichloroethene, and vinyl chloride. Following excavation and removal of the contamination source in 1997, the passive barrier (designed by EnviroMetal Technologies, Inc.) was installed in the summer of 1998.

Technology Description

This passive barrier system requires no operational energy and minimal maintenance, which results in a substantial cost savings over use of an alternative pump and treat system. Performance assessment of the barrier indicates that the barrier system is removing approximately 99% of the plume's primary contaminants.

This barrier system begins with the downgrade-side collection of groundwater in a subsurface hydraulic barrier (French drain) lined with high-density polyethylene. The drain is located in the unconfined aquifer at depths ranging from 8 to 15 feet below ground surface. Ground water is diverted through the drain to piping that transfers it by gravity to the reactive media treatment system. The system consists of two 10-foot (wide) by 5-foot (deep) cylindrical reactors in series, each of which contains 337 cubic feet of granular, reactive (zero-valent) iron. The reactors were installed below surface grade and were sized to treat groundwater at a flow rate of 1 gallon per minute for a duration of 20 hours. In the reactors, VOCs are dechlorinated to nonchlorinated hydrocarbons, and uranium in the oxidized state (U^{6+}) is converted to uranium in the reduced state (U^{4+}) and precipitated. Following treatment, ground water exits the barrier system directly through surface water that flows to retention ponds.

Status

EPA and DOE have monitored the influent and effluent of this barrier system on a quarterly basis since September 1998. In addition, water samples in 1-foot increments throughout the reactive media have been collected since project start-up to monitor containment breakthrough. To date, breakthrough of VOCs and uranium has been confined to the top 3 feet of the first reactor in the treatment sequence.

Cost

The barrier system was installed at a cost of approximately $4.7 million with an estimated annual treatment cost of $130,776. The total cost of the barrier system (based on 20 years of operation) is approximately $7.3 million. Alternatively, a conventional pump and treat

system could have been installed at an estimated cost of $1 million with annual treatment costs of $1.8 million, the total cost (based on 20 years of operation) of which would have been approximately $37.9 million. Use of the innovative barrier system technology thus results in an estimated cost savings of over $30 million over 20 years.

Case Study 2: MMTP - Total Petroleum Hydrocarbon (TPH) Measurement Technologies

As part of the MMT Program, demonstrations were conducted on several innovative field measurement devices for total petroleum hydrocarbons (TPH) in soil. Specifically, seven TPH measurement technologies were demonstrated at the Navy Base Ventura County site in Port Hueneme, California. The primary purpose of the demonstrations was to evaluate the innovative field measurement devices for TPH in soil based on comparison of their performance and cost to those of a conventional, off-site laboratory analytical method. The following seven field measurement devices were demonstrated:

- CHEMetrics, Inc., RemediAid™ Total Petroleum Hydrocarbon Starter Kit
- Wilks Enterprise, Inc., Infracal® TOG/TPH Analyzer, Models CVH and HATR-T
- Horiba Instruments, Incorporated, OCMA-350 Oil Content Analyzer
- Dexsil Corporation PetroFLAG™ Hydrocarbon Test Kit for Soil
- Environmental Systems Corporation Synchronous Scanning Luminoscope
- SiteLAB® Corporation Analytical Test Kit UVF-3100A
- Strategic Diagnostics, Inc., EnSys Petro Test System

To address the demonstration objectives, both environmental and performance evaluation (PE) samples were analyzed during the demonstration. The samples were collected from five areas located in three regions of the United States that were contaminated with gasoline, diesel, lubricating oil, or other petroleum product.

Following completion of the demonstrations, verification statements were prepared for each field measurement device. The verification statements provided detailed information for each device including durability, accuracy and precision, and cost. Although the devices exhibited varying levels of performance, the demonstrations indicated that caution should be exercised when considering five of the devices for site-specific field TPH measurement application. The demonstrations also indicated that two of the devices were reliable field measurement devices for TPH in soil.

Case Study 3: Ex-Situ Harbor Sediment Remediation (New York/New Jersey Harbor)

The U.S. EPA began working with BioGenesis Enterprises, Inc. in 1991. Under the SITE program, BioGenesis successfully tested its washing technology on oil-contaminated soil at a refinery. Subsequently, BioGenesis℠ Washing Technology was extended to fine-grained sediments and tested by Environment Canada.

Regulations governing ocean disposal of New York/New Jersey Harbor dredged material were changed in 1992, imposing more stringent biological and chemical test criteria. This resulted in larger volumes of material which are considered unsuitable for ocean disposal. In order to maintain safe passage for vessels, periodic dredging of the harbor channels is necessary. On an annual basis this maintenance dredging generates between 6 to 7 million cubic yards of sediment. Under the new rules passed in 1992, approximately 4 to 6 million cubic

yards annually now require some form of processing or decontamination prior to disposal of the material.

U.S. EPA Region 2 and Army Corps of Engineers, NY District, are jointly directing a project funded by the Water Resources Development Act (WRDA) to demonstrate decontamination technologies. Department of Energy-Brookhaven National Laboratory (BNL) is managing demonstrations by the technology vendors. Based on U.S. EPA SITE program and Environment Canada testing, BioGenesis was selected into the program. The WRDA project goal is to establish a production-scale facility able to treat 500,000 cubic yards of dredged material annually. In addition to successful removal or treatment of organic contaminants (including polynuclear aromatic hydrocarbons (PAH) and organochlorides such as dioxins, furans, and PCBs) and heavy metals, the WRDA project is addressing the additional issues of materials handling and beneficial use of treated or decontaminated material.

Technology Descriptions

The BioGenesis℠ Soil and Sediment Washing Process is an ex-situ, on-site extraction technology for cleaning organic pollutants and metals. Unlike other washing processes, BioGenesis℠ washing is a true cleaning process. It does not simply reduce volume as in conventional washing technology. Typical removal percentages range from 70-99% depending on process parameters and required cleanup levels.

The process begins by screening the contaminated sediment down to particle sizes less than ¼ inch in diameter. The material is then collected in a storage tank where water and a proprietary cleaning chemical are added and mixed to create a homogenized slurry. This slurry is next fed through the company's own proprietary, patented equipment where the sediment particles are separated from each other and the contaminants removed. The slurry is then dewatered using a variety of equipment including hydrocyclones, centrifuges, and sand filters. The treated dewatered sediment can then be used for beneficial use applications including manufactured soil and construction industry products such as bricks, coatings, and light aggregate. The liquid portion of the slurry is decontaminated using standard wastewater treatment techniques such as precipitation and oxidation.

Status

Since entering the WRDA project in 1995, BioGenesis has performed several successful optimization tests on NY/NJ Harbor sediment. In March 1999 the company completed a pilot project for the WRDA project using sediment supplied by the Port Authority of NY/NJ. The project finished on schedule and successfully cleaned over 700 yd^3 of sediment.

Based on the results from the pilot project, the U.S. EPA Region 2 approved the implementation of a commercial-scale facility capable of processing over 250,000 yd^3 per year. BioGenesis has teamed with Montgomery Watson Harza for engineering and BASF Corporation for chemicals. Design has been completed for the initial phase of full-scale implementation. BioGenesis is currently on site in Kearny, New Jersey decontaminating soil using washing technology first tested in 1992 in the SITE program. Full-scale production is anticipated to begin by the latter half of 2003.